

CLAIMS:

1. A shock absorbing steering apparatus for use in a vehicle, comprising:
a steering column to be fixed to a portion of a body of the vehicle
5 such that the steering column is releasable from the body of the vehicle and
movable in a forward direction of the vehicle in the event of a secondary
collision of an occupant of the vehicle upon a collision of the vehicle, one of
the steering column and said portion of the body of the vehicle including a
mounting portion, and the other of the steering column and said portion
10 including a holding portion; and
an impact energy absorbing member to be mounted on the mounting
portion, the impact energy absorbing member including an engaging portion
which is engageable with the holding portion and being deformable as the
steering column is moved in the forward direction of the vehicle while the
15 engaging portion is held in engagement with the holding portion, whereby
the impact energy absorbing member absorbs an impact energy generated
by the secondary collision.
2. The shock absorbing steering apparatus according to claim 1, further
20 comprising an engagement adjusting mechanism operable to permit or
inhibit an engagement between the engaging portion of the impact energy
absorbing member and said holding portion.
3. The shock absorbing steering apparatus according to claim 2, wherein
25 the engagement adjusting mechanism includes an actuator operable
between a first position for permitting the engagement between the
engaging portion and the holding portion, and a second for inhibiting said
engagement.
- 30 4. The shock absorbing steering apparatus according to claim 3, wherein
the engagement adjusting mechanism is arranged such that an impact
energy absorbing load to be generated by deformation of the impact energy
absorbing member does not act on said actuator when the engaging portion
is brought into engagement with the holding portion.
- 35 5. The shock absorbing apparatus according to any one of claims 2-4,
wherein the engagement adjusting mechanism is operable to permit or

inhibit the engagement between the engaging portion and the holding portion, on the basis of an output of a sensor provided to detect a state of the vehicle or an occupant of the vehicle.

5 6. The shock absorbing steering apparatus according to claim 2, wherein the engagement adjusting mechanism includes a mechanism operable to cause the holding portion to be displaced by an amount corresponding to a magnitude of an impact applied to the body of the vehicle upon the collision
10 the engaging portion and the holding portion when the amount of displacement of the holding portion is larger than a predetermined threshold.

15 7. The shock absorbing steering apparatus according to claim 6, wherein said mechanism operable to cause the holding portion to be displaced by the amount corresponding to the magnitude of the impact is arranged to cause a displacement of the holding portion by utilizing an inertia mass of the holding portion.

20 8. The shock absorbing steering apparatus according to any one of claims 1-7, wherein the impact energy absorbing member is arranged to be positioned relative to the mounting portion such that the engaging portion and the holding portion are spaced from each other by a predetermined free-running distance in said forward direction before the steering column is
25 moved in the forward direction relative to the portion of the body of the vehicle.

30 9. The shock absorbing steering apparatus according to claim 8, wherein one of the engaging portion and the holding portion includes a recessed part which has a recess engageable with the other of the engaging and holding portions and cooperates with said other to define therebetween the predetermined free-running distance.

35 10. The shock absorbing steering apparatus according to any one of claims 1-9, further comprising an initial-load adjusting mechanism operable to reduce a rate of increase of an impact energy absorbing load to be generated by the impact energy absorbing member in an initial period of the

absorption of the impact energy, the initial-load adjusting mechanism being provided at at least one position selected from among: a position between the impact energy absorbing member and the steering column; a position on the impact energy absorbing member; and a position between the impact
5 energy absorbing member and the steering column.

11. The shock absorbing steering apparatus according to any one of claims 1-10, wherein the engaging portion of the impact energy absorbing member and the holding portion are engageable with each other so as to
10 provisionally hold the steering column on the portion of the body of the vehicle through the impact energy absorbing member when the steering column is fixed to the portion of the body of the vehicle.

12. The shock absorbing steering apparatus according to any one of claims 1-11, wherein the impact energy absorbing member is a plate having an end
15 portion formed as said engaging portion.

13. The shock absorbing steering apparatus according to claim 12, wherein the engaging portion and the holding portion are arranged such that the
20 engaging portion receives a shearing load after the engaging portion is brought into engagement with the holding portion.

14. The shock absorbing steering apparatus according to claim 12 or 13, wherein the impact energy absorbing member includes a plurality of plates
25 which are superposed on each other and each of which has said engaging portion.

15. The shock absorbing steering apparatus according to any one of claims 12-14, wherein the impact energy absorbing plate includes a generally
30 U-shaped portion consisting of a curved section and two arm sections extending from respective opposite ends of the curved section, the impact energy absorbing member being arranged to be mounted on said mounting portion such that the two arm sections extend in a direction almost parallel to a direction of movement of the steering column relative to the portion of
35 the body of the vehicle and such that the mounting portion is sandwiched by and between the two arm sections in a direction of thickness of the plate of the impact energy absorbing member, said energy absorbing member being

deformed by one end portion of the mounting portion, during the movement of the steering column relative to the portion of the body of the vehicle in the forward direction of the vehicle with the engaging portion held in engagement with the holding portion, such that a position of the curved section in the impact energy absorbing member is gradually changed, whereby the impact energy generated by the secondary collision is absorbed in the process of deformation of the impact energy absorbing member.

16. The shock absorbing steering apparatus according to claim 15, wherein the engaging portion is formed integrally with one of the two arm sections such that the engaging portion extends, from one end of said one arm section which is remote from the curved section, in a direction away from the other of the two arm sections.

17. The shock absorbing steering apparatus according to any one of claims 1-16, wherein the steering column includes a column body, and a column holder structure which holds the column body and which is fixed to said portion of the body of the vehicle such that the column holder structure is releasable and movable away from the portion of the body of the vehicle in the forward direction of the vehicle, in the event of said secondary collision, and the column holder structure includes said mounting portion while said portion of the body of the vehicle is provided with said holding portion.

18. The shock absorbing steering apparatus according to claim 17, wherein the column holder structure includes a pair of arms which are spaced apart from each other in a lateral direction of the vehicle, and a central portion which is located almost intermediate between the pair of arms in the lateral direction, the column holder structure being fixed at the pair of arms to said portion of the body of the vehicle, and the mounting portion being located in the central portion of the column holder structure.

19. The shock absorbing steering apparatus according to claim 17 or 18, wherein the column holder structure holds the column body through a tilting mechanism.

20. The shock absorbing steering apparatus according to any one of claims 17-19, wherein the column holder structure holds the column body through

a telescopic mechanism.

21. The shock absorbing steering apparatus according to any one of claims 17-20, wherein the impact energy absorbing member is a plate, and includes
5 a generally U-shaped portion consisting of a curved section and two arm sections extending from respective opposite ends of the curved section, and one of the two arm sections includes an end portion terminating in said engaging portion, the impact energy absorbing member being arranged to be mounted on said mounting portion such that the two arm sections extend in
10 a direction almost parallel to a direction of movement of the steering column relative to the portion of the body of the vehicle and such that the mounting portion is sandwiched by and between the two arm sections in a direction of thickness of the plate of the impact energy absorbing member, the impact energy absorbing member being deformed by a front end portion of the
15 mounting portion, during the movement of the steering column relative to the portion of the body of the vehicle in the forward direction of the vehicle with the engaging portion held in engagement with the holding portion, such that a position of the curved section in the impact energy absorbing member is gradually changed, whereby the impact energy generated by the
20 secondary collision is absorbed in the process of deformation of the impact energy absorbing member.

22. The shock absorbing steering apparatus according to claim 21, wherein the engaging portion is formed integrally with one of the two arms such that
25 the engaging portion extends, from an end of said end portion of said one arm section which end is remote from the curved section, in a direction away from the other of the two arm sections.

23. The shock absorbing steering apparatus according to claim 21 or 22,
30 wherein the front end portion of the mounting portion is formed as a guide portion for guiding a displacement of the curved section of the impact energy absorbing member along a curvature of the front end portion while the impact energy absorbing member is deformed.

24. The shock absorbing steering apparatus according to claim 23, wherein
35 the mounting portion of the column holder structure consists of two plates which are superposed on each other such that one end portion of one of the

two plates projects from a corresponding front end face of the other of the two plates in the forward direction of the vehicle, and the guide portion of the mounting portion is constituted by a guide member which is generally J-shaped in cross section and which has a short arm and a long arm, the guide member being fitted on said one end portion of said one plate such that a rear end face of the short arm is held opposed to the front end face of said other plate.

25. The shock absorbing steering apparatus according to claim 23, wherein the mounting portion of the column holder structure includes a plate having a generally U-shaped projecting end portion which constitutes the guide portion.

26. The shock absorbing steering apparatus according to any one of claims 23-25, wherein the impact energy absorbing member is mounted on the mounting portion such that there is an air gap between the curved section and the guide portion.

27. The shock absorbing steering apparatus according to any one of claims 21-26, further comprising positioning and holding means for positioning and holding said one arm section of the impact energy absorbing member with respect to the column holder structure.

28. The shock absorbing steering apparatus according to claim 27, wherein the positioning and holding means includes a pair of positioning and holding pieces disposed on opposite sides of said one arm section such that the pair of positioning and holding pieces are spaced from each other in a direction of width of said one arm section.

29. The shock absorbing steering apparatus according to claim 28, wherein the pair of positioning and holding pieces have respective mutually opposed slant surfaces which are formed such that a distance between the opposed slant surfaces decreases in a direction from said other arm section toward said one arm section.

30. The shock absorbing steering apparatus according to claim 29, wherein said one arm section of the generally U-shaped portion of the impact energy

absorbing member is supported by a portion of the mounting portion, at an inner surface of said one arm section which faces inwardly of the generally U-shaped portion.

5 31. The shock absorbing steering apparatus according to any one of claims
28-30, wherein the engaging portion is formed integrally with said one arm
section such that the engaging portion extends, from one end of said one
arm section which is remote from the curved section, in a direction away
10 has a larger height than the pair of positioning and holding pieces, as
measured from an outer surface of said one arm section that is opposite to
an inner surface thereof which faces inwardly of the generally U-shaped
portion, the engaging portion being engageable at a free end portion thereof
with said holding portion, and having a width smaller than a distance
15 between the pair of positioning and holding pieces, at a height position of
the engaging portion which corresponds to the height of the pair of
positioning and holding pieces.

20 32. The shock absorbing steering apparatus according to any one of claims
27-31, wherein the mounting portion includes a guide member located at a
front end portion thereof and operable to guide a displacement of the curved
section of the impact energy absorbing member while the impact energy
absorbing member is deformed, and the guide member includes a rear
extension extending in a rearward direction of the vehicle, the pair of
25 positioning and holding means being provided on the rear extension.

30 33. The shock absorbing steering apparatus according to claim 32, wherein
the rear extension of the guide member includes a positioning and holding
portion for positioning and holding the other of the two arm sections of the
impact energy absorbing member.

35 34. The shock absorbing steering apparatus according to claim 27, wherein
the mounting portion includes a supporting portion, and the positioning and
holding means includes a generally rectangular three-sided clip having an
elastically deformable portion which cooperates with the supporting portion
to elastically hold therebetween said one arm section of the generally
U-shaped portion of the impact energy absorbing member in elastically

pressing contact therewith in a direction of thickness of said one arm section.

35. The shock absorbing steering apparatus according to claim 27, wherein
5 the mounting portion includes a supporting portion, and the positioning and holding means includes a holding band which cooperates with the supporting portion to hold said one arm section of the generally U-shaped portion of the impact energy absorbing member, the holding band having a variable effective length of holding.

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36. The shock absorbing steering apparatus according to any one of claims 21-35, wherein the column holder structure has a pair of slots which are spaced apart from each other in a lateral direction of the vehicle and through which the column holder structure is attached to the portion of the
15 body of the vehicle such that the column holder structure is releasable and movable away from the portion of the body of the vehicle in the forward direction of the vehicle, the column holder structure further including a central portion which is located almost intermediate between the pair of slots in the lateral direction and which includes the mounting portion on
20 which the impact energy absorbing member is mounted,

and wherein the impact energy absorbing member includes a pair of wing portions which extend from said one arm section in respective opposite directions parallel to the lateral direction of the vehicle and which are provided with respective cylindrical portions which are respectively
25 press-fitted in the pair of slots of the column holder structure and which are releasable from the pair of slots when the column holder structure is moved away from the portion of the body of the vehicle in the forward direction of the vehicle.

30 37. The shock absorbing steering apparatus according to any one of claims 1-36, further comprising an energy-absorbing-load changing mechanism operable to change an impact energy absorbing load to be generated by deformation of the impact energy absorbing member, depending upon a velocity of the movement of the steering column in the forward direction of
35 the vehicle relative to the portion of the body of the vehicle.

38. The shock absorbing steering apparatus according to claim 37, wherein

the energy-absorbing-load changing mechanism increases the impact energy absorbing load with an increase in the velocity of movement of the steering column.

5 39. The shock absorbing steering apparatus according to claim 37 or 38, wherein the energy-absorbing-load changing mechanism changes the impact energy absorbing load such that the impact energy absorbing load is larger when the velocity of movement of the steering column is higher than a predetermined threshold, than when the velocity is not higher than the
10 predetermined threshold.

40. The shock absorbing steering apparatus according to any one of claims 37-39, wherein the energy-absorbing-load changing mechanism changes the impact energy absorbing load by changing a force of resistance to the
15 deformation of the impact energy absorbing member.

41. The shock absorbing steering apparatus according to claim 40, wherein the impact energy absorbing member is a plate, and includes a generally U-shaped portion consisting of a curved section and two arm sections
20 extending from respective opposite ends of the curved section, and one of the two arm sections includes an end portion terminating in said engaging portion, the impact energy absorbing member being arranged to be mounted on said mounting portion such that the two arm sections extend in a direction of movement of the steering column relative to the portion of the
25 body of the vehicle and such that the mounting portion is sandwiched by and between the two arm sections in a direction almost parallel to a direction of thickness of the plate of the impact energy absorbing member, the impact energy absorbing member being deformed by an end portion of the mounting portion, during the movement of the steering column relative
30 to the portion of the body of the vehicle in the forward direction of the vehicle with the engaging portion held in engagement with the holding portion, such that a position of the curved section in the impact energy absorbing member is gradually changed, whereby the impact energy generated by the secondary collision is absorbed in the process of
35 deformation of the impact energy absorbing member,

and wherein said energy-absorbing-load changing mechanism includes (a) a deformation-resistance increasing member provided on said

mounting portion and engageable with the impact energy absorbing member so as to increase the force of resistance to the deformation of the impact energy absorbing member, and (b) an engaging mechanism operable to cause engagement of the deformation-resistance increasing member with the impact energy absorbing member when a velocity of movement of the impact energy absorbing member relative to said front end portion of the mounting portion is higher than a predetermined threshold.

42. The shock absorbing steering apparatus according to claim 40, The shock absorbing steering apparatus according to claim 40, wherein the impact energy absorbing member is a plate, and includes a generally U-shaped portion consisting of a curved section and two arm sections extending from respective opposite ends of the curved section, and one of the two arm sections includes an end portion terminating in said engaging portion, the impact energy absorbing member being arranged to be mounted on said mounting portion such that the two arm sections extend in a direction almost parallel to a direction of movement of the steering column relative to the portion of the body of the vehicle and such that the mounting portion is sandwiched by and between the two arm sections in a direction almost parallel to a direction of thickness of the plate of the impact energy absorbing member, the impact energy absorbing member being deformed by an end portion of the mounting portion, during the movement of the steering column relative to the portion of the body of the vehicle in the forward direction of the vehicle with the engaging portion held in engagement with the holding portion, such that a position of the curved section in the impact energy absorbing member is gradually changed, whereby the impact energy generated by the secondary collision is absorbed in the process of deformation of the impact energy absorbing member,

and wherein said energy-absorbing-load changing mechanism includes (a) a movable member provided on said mounting portion and engageable with the impact energy absorbing member such that the movable member is movable when the impact energy absorbing member is displaced relative to said front end portion of the mounting portion, and (b) a movable-member-movement restricting mechanism operable to restrict a movement of the movable member when a velocity of movement of the movable member is higher than a predetermined threshold.